Borexino

Borexino a Genova

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Data analysis:

Ruolo di Genova cruciale nella analisi

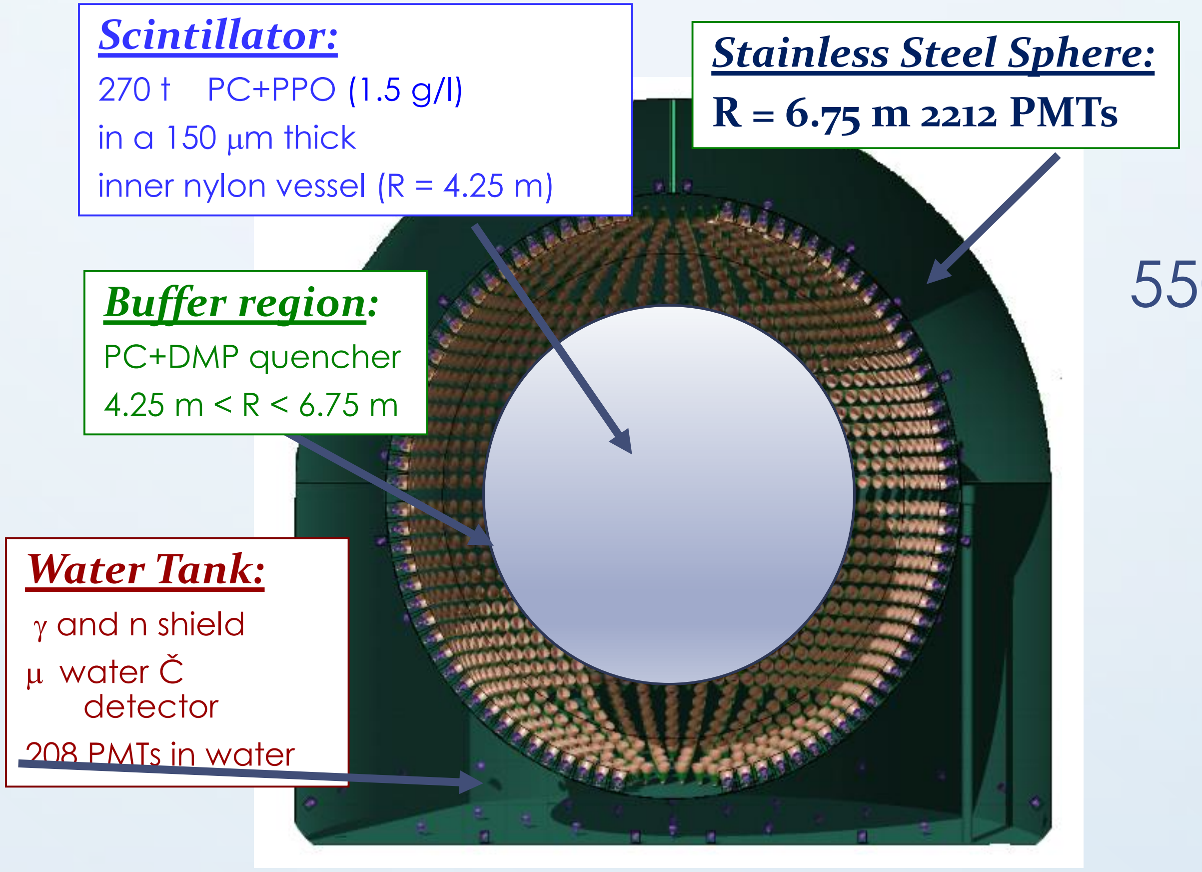
GT: physics coord per 8 anni (2010-2018)

SZ : resp. Working group anti-nu

AC: resp. Working group Monte Carlo

MP: co-spoke

Borexino detector



- **ν detection:** $\nu_x + e^- \rightarrow \nu_x + e^-$
- **Energy E:** **PMT hit/charge**)
- **Position:** PMT hit time

550 N_p @1MeV σ_E= 50 KeV@1MeV

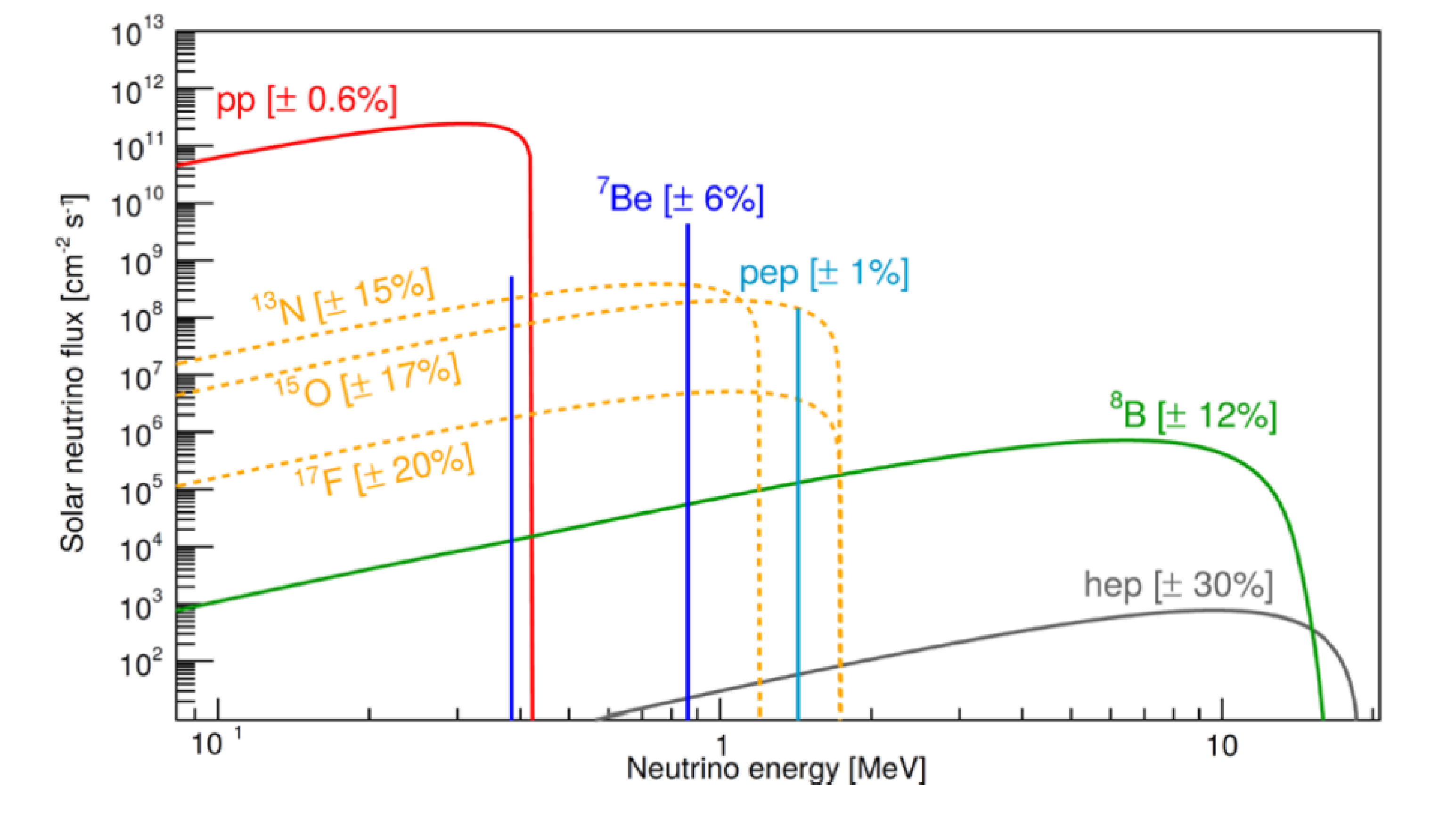
$\sigma_{x,y,z}$=10 cm@1MeV

Presa dati dal 2007

- Neutrini solari
- Geo-neutrini
- Processi rari

Excellent radiopurity, better than design goals

Solar neutrino spectrum



$4p \rightarrow {}^4He + 2e^+ + 2\nu_e + (24.69+2\cdot 1.022)MeV$

$<E_\nu>$ ~ 0.53 MeV, 2% of total energy produced

- pp chain
- CNO chain

- **Alcuni flussi di ν sono sensibili a parametri del modello solare (metallicita') CNO in particolare**
- **Oscillazioni neutrini (LMA-MSW)**

Comprehensive measurement of the solar neutrino spectrum from the proton-proton nuclear fusion chain with Borexino

- **Full pp chain measured with a single detector**
- **Unified analysis**
- **New results on pp, 7Be, pep, 8B**
- **Phase 2 data (after a purification of the scintillator)**

Paper submitted

- 5 σ evidence of pep
- Including systematics

	Earlier result (cpd/100t)	Actual result (cpd/100t)	Precision
pp	144±13±10	$134 \pm 10^{+6}_{-10}$	11%
$^{7}Be^{(*)}$	$46.0 \pm 1.5^{+1.6}_{-1.5}$	$46.3 \pm 1.1^{+0.4}_{-0.7}$	4.7→2.7%
pep	3.1±0.6±0.3	(HZ) $2.43 \pm 0.36^{+0.15}_{-0.22}$ (LZ) $2.65 \pm 0.36^{+0.15}_{-0.24}$	22→16%

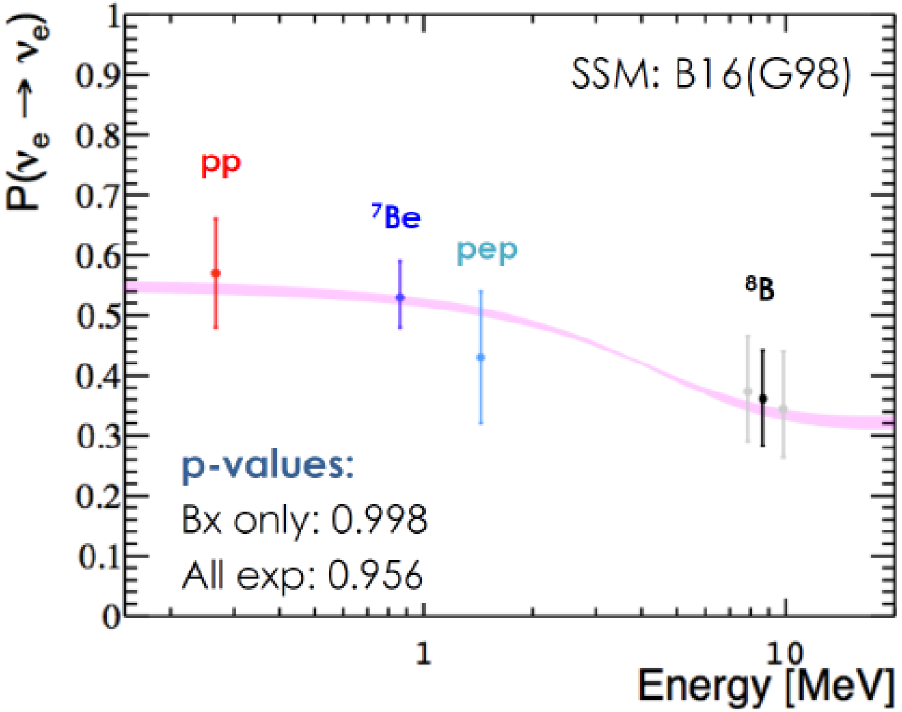
Event rate due ^{8}B ν in our analysis energy region (the lowest thres. among RT detectors, 3.2 MeV)

$$0.220^{+0.015}_{-0.016}\,(stat)\,^{+0.006}_{-0.006}\,(syst)\ \mathrm{cpd}/100\,\mathrm{t}.$$

+ best limit on ν magnetic moment
+ paper on Borexino MC (resp. Genova)

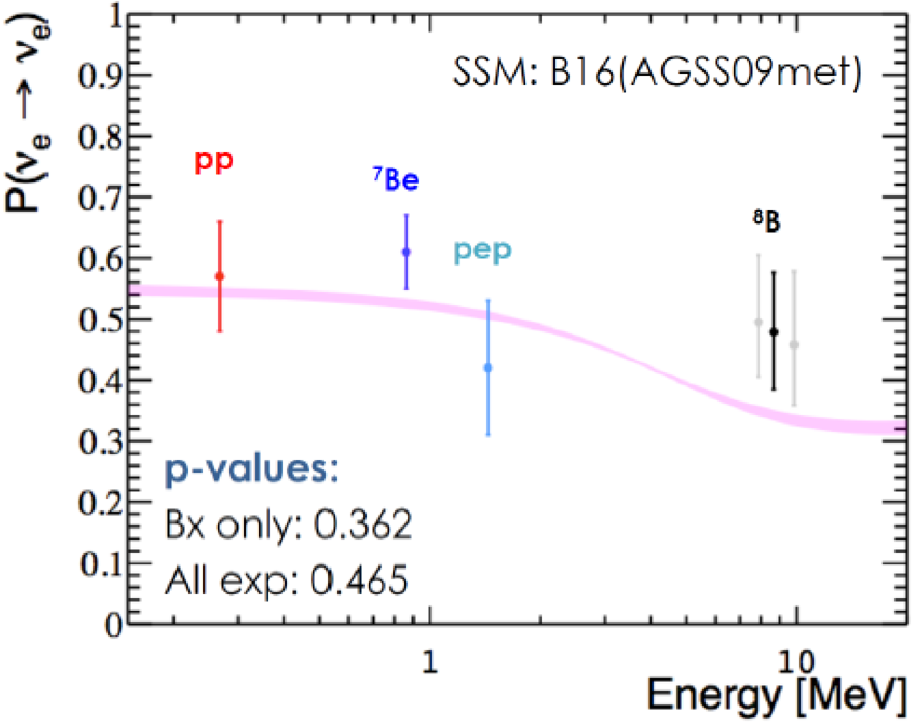
MSW-LMA : electron neutrino survival probability

High metallicity SSM

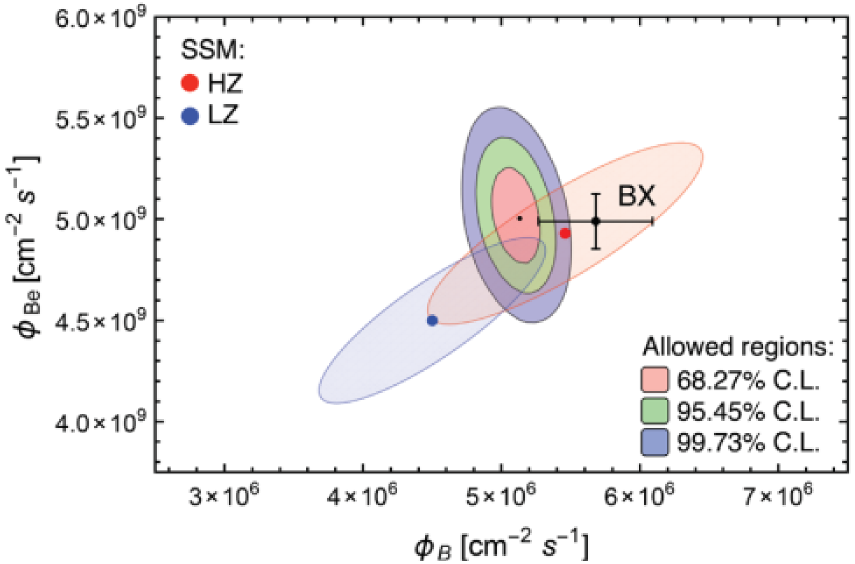


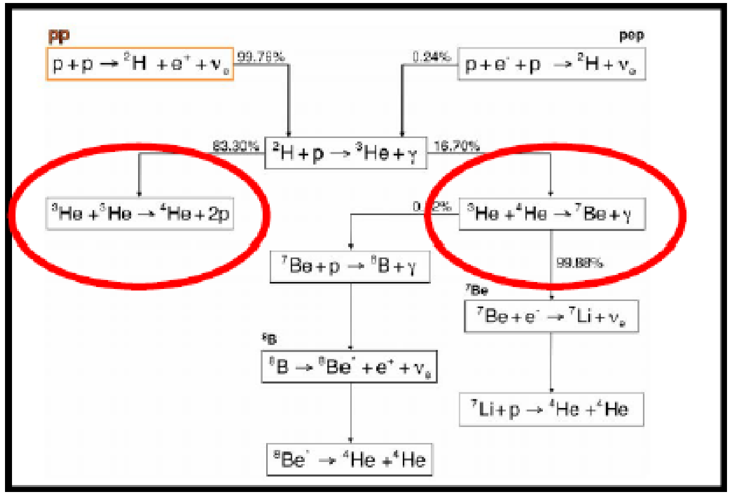
MSW error band is 1σ

Low metallicity SSM



Borexino vs SSM





- **Global fit to all solar + Kamland data (including the new ^{7}Be result from BX)**

$$f_{Be} = \frac{\Phi(\mathrm{Be})}{\Phi(\mathrm{Be})_{HZ}} = 1.01 \pm 0.03$$

$$f_B = \frac{\Phi(\mathrm{B})}{\Phi(\mathrm{B})_{HZ}} = 0.93 \pm 0.02$$

- **a hint towards the HM :**

  LZ is excluded by BX data at 1.8σ level
- **theoretical errors are dominating**

$$R \equiv \frac{<^3\mathrm{He} +^4\mathrm{He}>}{<^3\mathrm{He} +^3\mathrm{He}>} = \frac{2\phi(^7\mathrm{Be})}{\phi(\mathrm{pp}) - \phi(^7\mathrm{Be})}$$

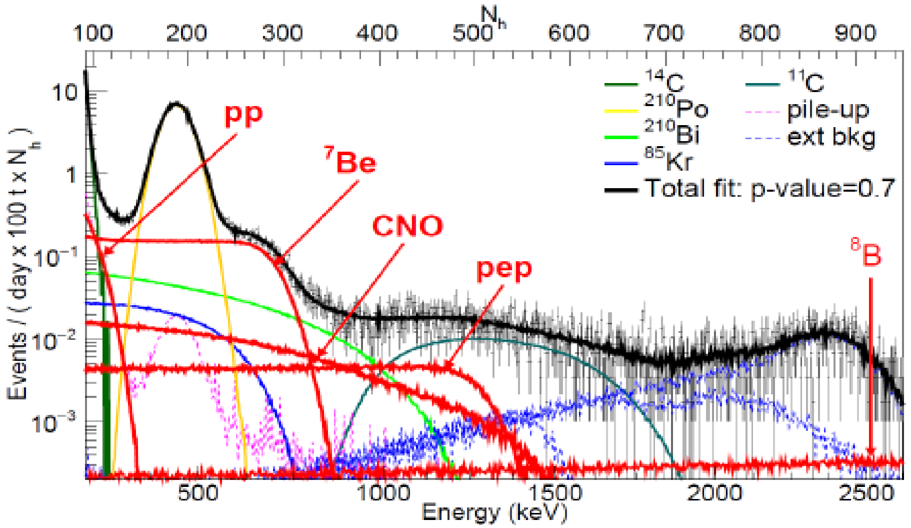
R(HZ)=0.180±0.011
R(LZ)=0.161±0.010

From the pp and ^{7}Be fluxes measurement

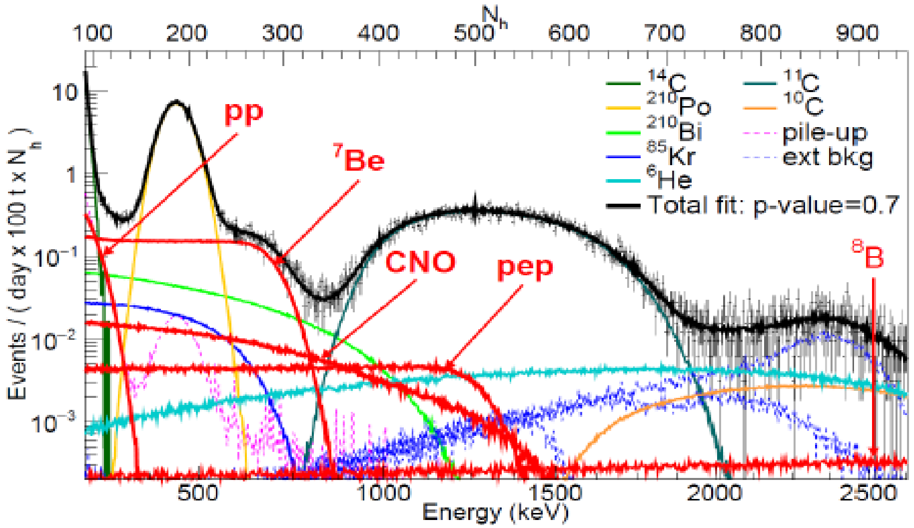
R(BRX)=$0.178^{+0.027}_{-0.023}$

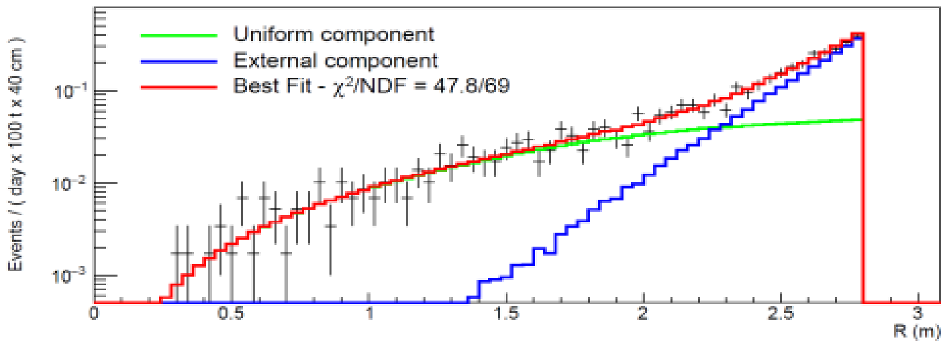
Multivariate fit example

$L(^{11}C_{sub})$

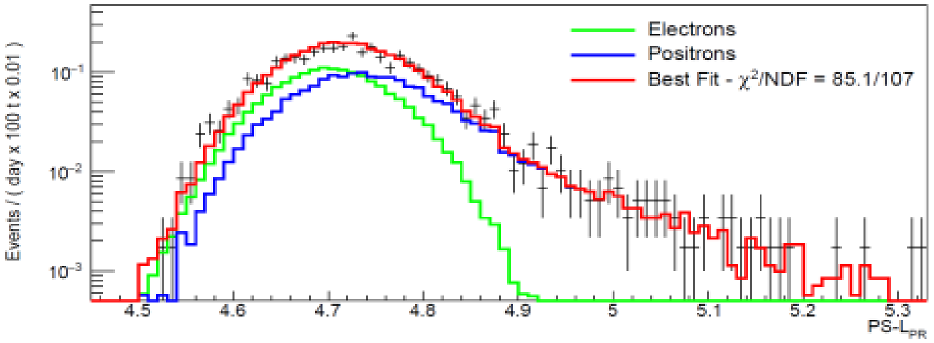


$L(^{11}C_{tag})$





L(Rad)



L(PS)

In progress: controllo background per misura ν CNO

1) Reduce ^{210}Bi by purification: partially achieved

2) Infer the ^{210}Bi activity from the ^{210}Po vs time
^{210}Bi-^{210}Po out of equilibrium: we see an high ^{210} Po rate

$$n_{\mathrm{Po}}(t) = [n_{\mathrm{Po},0} - n_{\mathrm{Bi}}]\, \exp(-t/\tau_{\mathrm{Po}}) + n_{\mathrm{Bi}}\,.$$

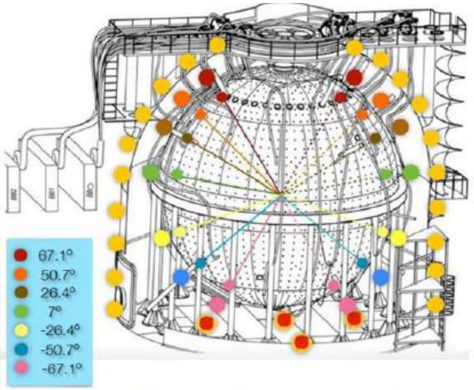
^{210}Pb $\xrightarrow{\beta\ (63\ \mathrm{KeV})}$ ^{210}Bi $\xrightarrow{\beta}$ ^{210}Po $\xrightarrow{\alpha}$ ^{206}Pb

$T_{1/2}$=22y — 5 days — 138 days — stable

- Look at the ^{210}Po time decay: the rate at regime is due to ^{210}Bi

But:
Convection brings contaminants from the surface of the vessel to the inner part of the scintillator

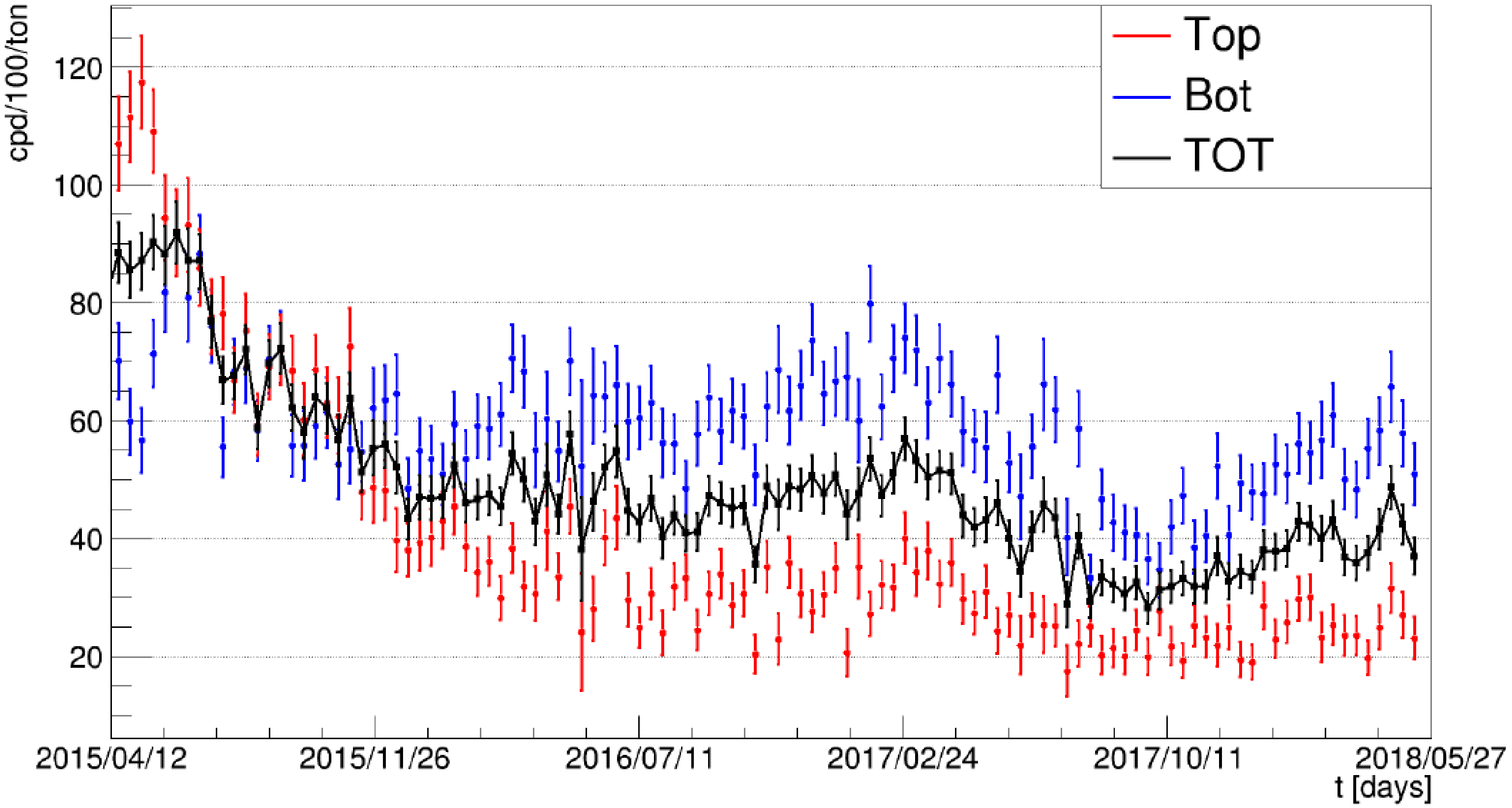
- Thermal insulation
- Stable temperature



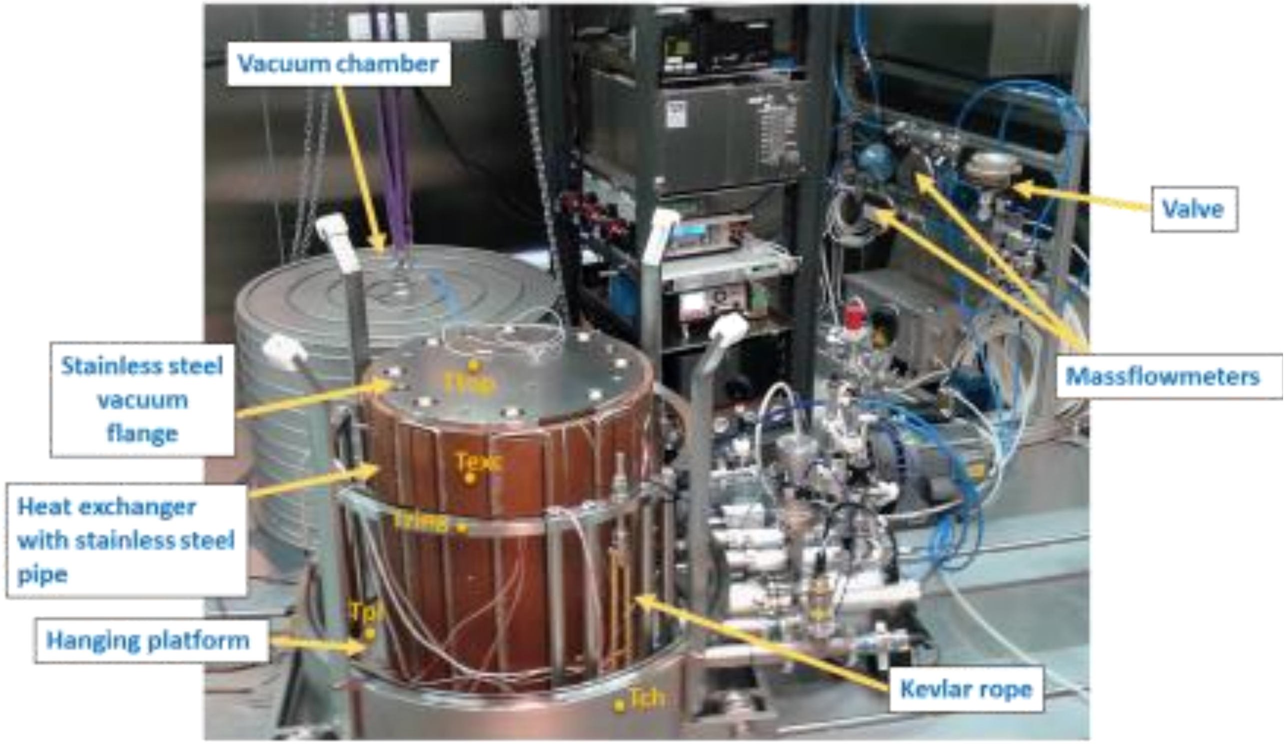
Installation of temperature sensors

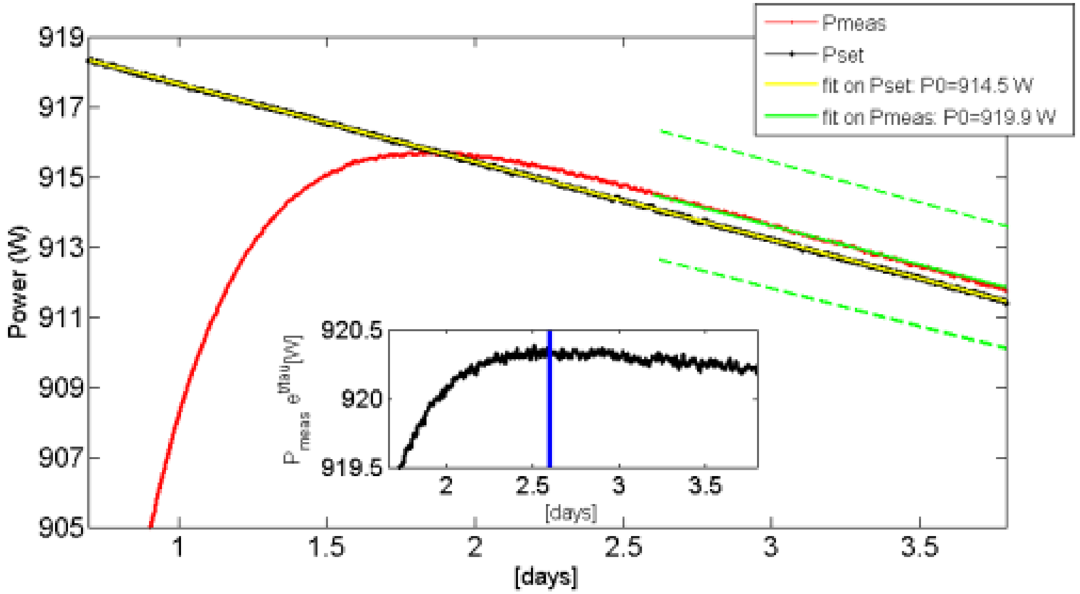
Temperature stability crucial for understanding background
Avoid fluid movement
Convection brings contaminants from the nylon walls in the inner part of the detector
Understand 210Po decay for inferring Bi210
Increase sensitivity to CNO measurement

^{210}Po rate vs time



Il calorimetro per la misura dell'attività della sorgente di SOX





Precisione: 0.2% nella misura della potenza

Montaggio e calibrazioni terminate entro dic 2017

un'attività per buona parte genovese
(insieme al TUM di Monaco)
Borexino Genova + Riccardo M. +Stefania F.

PREPARED FOR SUBMISSION TO JINST

A calorimeter for the precise determination of the activity of the ^{144}Ce-^{144}Pr anti-neutrino source in the SOX experiment

L'articolo è stato sottomesso

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1.2 FTE

Richieste: supporto per mantenimento elettronica (circa 1 mese/uomo)
servizio elettronica